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#### Development of a Robust Setup for the Study of Wetting Characteristics of Low Melting Point Metals

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# Development of a Robust Setup for the Study of Wetting Characteristics of Low Melting Point

Metals

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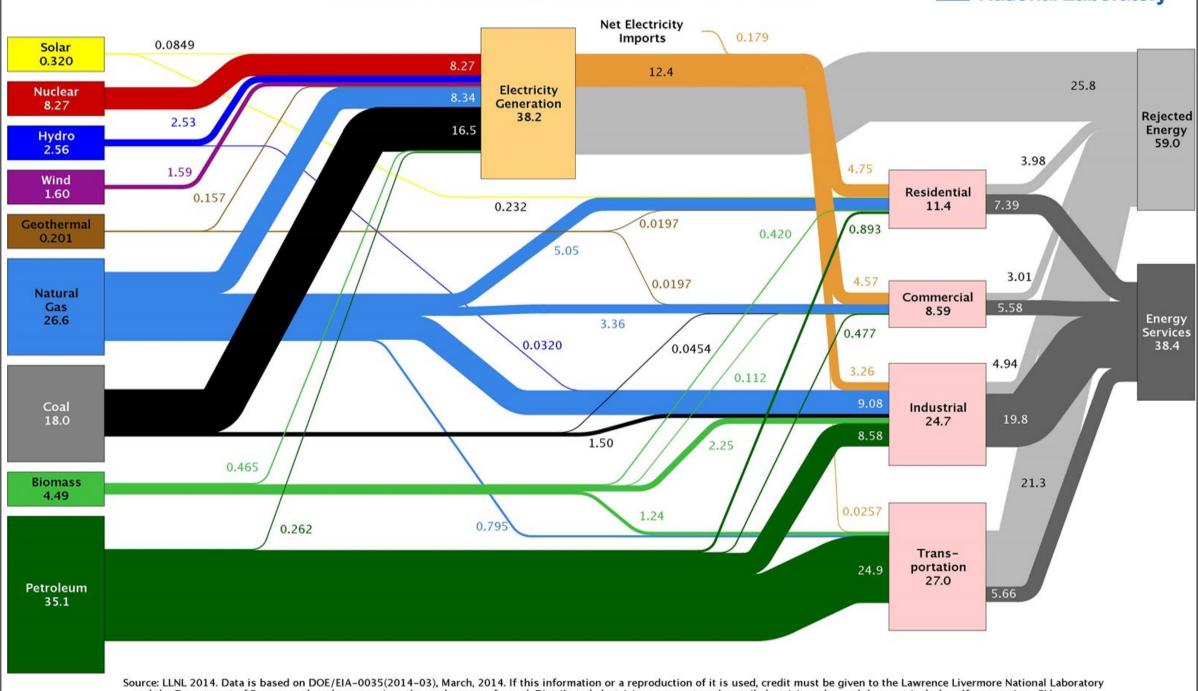


## Motivation

- Energy use is very inefficient
  - Approx. 60% rejected mostly in the form of waste heat
- Low melting point metals are promising for applications in thermal energy management, conversion, and storage



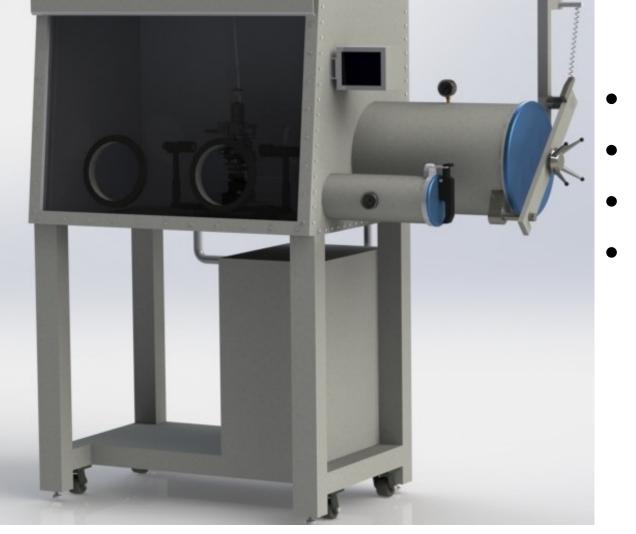
Lawrence Livermore National Laboratory



# **Experimental Equipment**

## **MBRAUN LABstar Glove Box**

## **Rame-Hart Model 250 Goniometer**



#### Inert gas environment

- $O_2$  levels < 0.5 ppm
- $H_2O$  levels < 0.5 ppm
- Pressure control



- Measures
- Contact angle
- Surface tension
- Adjustable stage

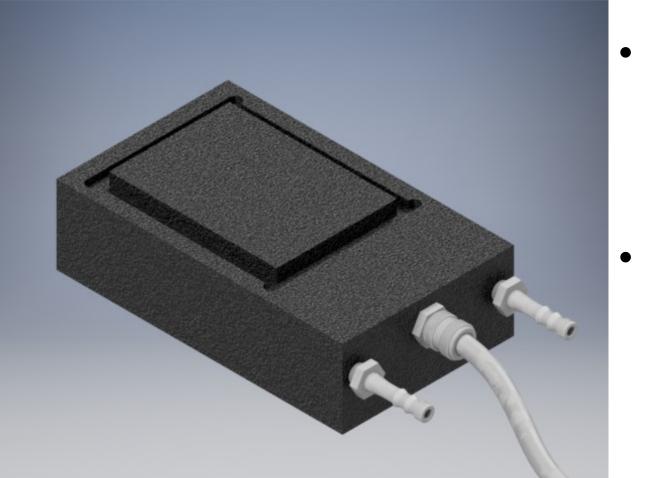
Source: LLNL 2014. Data is based on DOE/EIA-0035(2014-03), March, 2014. If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports sumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant "heat rate." The efficiency of electricity production s calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential and commercial sectors 80% for the industrial sector, and 21% for the transportation sector. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527

**Above**: Energy use in the US for the year 2013. The figure shows approximately 60% of energy is rejected. **Retrieved from:** www.llnl.gov/missions/energy

#### Rame-Hart Elevated Temperature Syringe

- Provides an elevated temperature up to 300° C
- Fluid may be dispensed at a temperature equivalent to the sample surface
- Reduces the temperature gradient across the droplet

### **Rame-Hart Hot Plate**



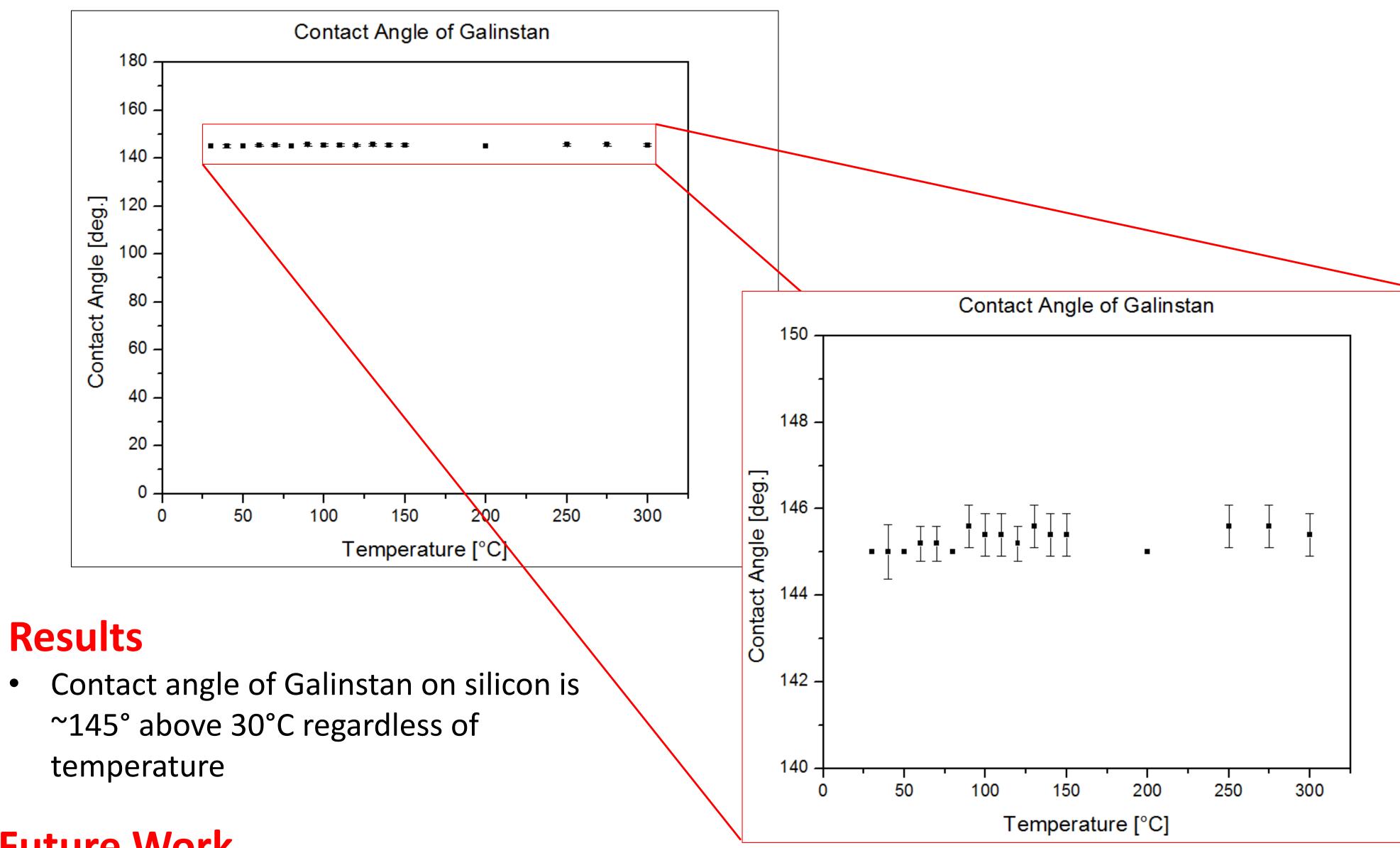
- Provides an elevated sample temperature up to 300° C Can be cooled
- to well below ambient temperature

# Low Melting Point Metals

## **Appealing Properties**

- High thermal conductivity
- Low melting temperature
- Good electrical conductivity
- Small volume expansion during phase change

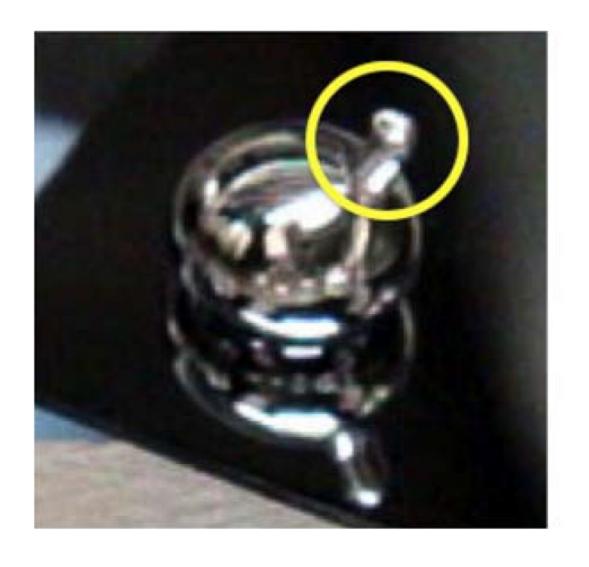
## **Preliminary Results and Future Work**



- High boiling point
- Large latent heat of phase change

### **Adverse Characteristics**

- Oxidize readily at > 1 ppm oxygen
  - Must be handled in inert environment





Liu, T.; Sen, P.; Kim, C. J. Characterization of Nontoxic Liquid-Metal Alloy Galinstan for Applications in Microdevices. *J. Microelectromechanical Syst.* **2012**, *21*, 443–450.

#### **Future Work**

- Contact angles of Galinstan below ambient
- Various substrate materials

Tungsten, Pyrex, Tantalum, etc.

Various low melting point metals.
Gallium, Indium, Tin, Bismuth alloys



#### **Acknowledgements**

This work has been supported by